

NEW FUNGICIDES FOR CONTROL OF PHYTOPHTHORA CINNAMOMI

G. A. Zentmyer, H. Ohr, F. B. Guillemot, S. D. Campbell, and G. King*

Department of Plant Pathology, University of California, Riverside

Several new organic fungicides are showing promise for application to established avocado trees, for prevention or control of *Phytophthora* root rot. There has been increased emphasis recently by some of the agricultural chemical companies on soil fungicides, and some of these new materials are especially effective on the water molds (Oomycetes), the group of fungi in which the avocado root rot fungus is classified.

We are now experimenting, in greenhouse and initial field trials with three organic fungicides: ethazol (trade names Terrazole and Truban) that has been available for experimental testing for several years, and two newer materials, from Ciba Geigy Corp. in Switzerland—CGA 48988, and from Rhone-Poulenc Co. in France—Aliette or LS 74-783 which is currently distributed in the United States by the Rhodia Chemical Company.

These chemicals are currently available only for experimental testing as none of them is yet registered for use in this country on avocado trees. Terrazole, through the Olin Chemical Company, is the chemical that is closest to possible registration; the Olin Co. has obtained considerable residue and toxicological data that is necessary before such chemicals can obtain governmental approval. Initial data are now being developed on the other two materials, so that the date for their possible approval for use in the avocado industry is sometime in the future.

This approach appears to be very promising, however, so that we are presenting this brief progress report. Chemicals of this type are especially interesting for use on a tree crop such as the avocado, as in contrast to fumigants, they are non-toxic to the plant at levels that prevent the fungus from infecting roots, and thus can be applied to trees in the irrigation water, or spread on the soil in a granular form and watered in. Another aspect of this type of fungicide that has a great deal of promise, is that of combining the moderate levels of resistance that are available with low dosages of fungicides. This approach has given excellent results in several greenhouse trials.

Ethazol (trade names: Terrazole and Truban)—this fungicide has been under test for several years; chemically it is an organic sulfur compound, a thiadiazole. It is very effective in preventing growth of *Phytophthora cinnamomi* in the laboratory, reducing growth 95 percent at 2.25 ppm. Olin Chemical Company is the primary manufacturer. This fungicide has given good control of *Phytophthora* root rot of avocado seedlings in a number of our tests in the greenhouse, when applied as a drench to the infested soil. It has also been effective at low dosages in supplementing resistance. We have had a number of field plots in several of the southern California counties, testing Terrazole for prevention of root rot development when applied around trees in various disease

conditions. Results have been somewhat variable, but benefit has been obtained on several plots. One approach that is being emphasized more at present is that of preventive maintenance—applying the fungicide to healthy trees on the margin of a diseased area or to young healthy trees in a newly planted area that may be susceptible to root rot.

Ciba-Geigy 48988—this is a member of a new group of fungicides developed by the Ciba-Geigy Chemical Company in Switzerland—the acyl alanine fungicides, which are active against many of the water mold group, including such widespread diseases as late blight of potato, and the downy mildews including downy mildew of grape. These fungicides have shown activity both when applied to the foliage to prevent leaf diseases and when applied to the soil to prevent root rots. CGA 48988 has been very effective in our greenhouse tests for preventing *Phytophthora* root rot of avocado seedlings and of seedlings of *Persea indica* when applied to the soil. Frequent low dosage applications, in a simulated drip system have also given good results. This chemical is also very effective in preventing growth of *P. cinnamomi* in our laboratory culture tests; it reduces growth by 90 percent at 2.5 ppm in liquid culture. CGA 48988 also has systemic activity upward; for example when applied to the soil, it controls *Phytophthora* cankers on the stem of avocado.

Aliette (LS 74-783)—this is representative of another new and quite different group of fungicides developed by the Rhone-Poulenc Company in Lyon, France. This fungicide is aluminum ethyl phosphite, a simple and unique molecule. The company also has developed a sodium salt, LS 73-1038, which we have tested in Riverside. These fungicides, as with the others mentioned above, are active primarily against the water molds, including *Phytophthora* root rots, downy mildew of grape and other similar diseases. *Aliette* is an unusual fungicide in that it does not affect growth of *P. cinnamomi* in laboratory culture tests, even at 250 ppm, but is still effective in controlling root rot when applied to soil or to the plant. *Aliette* and the sodium salt are also very active primarily in our greenhouse tests for controlling *Phytophthora* root rot of avocado seedlings and of *Persea indica*, when applied as a soil drench. This group of fungicides also has the unusual property of systemic activity downward; when applied as a spray to leaves of seedlings in the greenhouse. *Aliette* reduces root rot significantly.

These fungicides have all been effective, in various dosages, when applied to infested soil in greenhouse tests to control *Phytophthora* root rot of avocado seedlings and of the avocado relative, *Persea indica*.

In a greenhouse test with *Persea indica*, the susceptible avocado relative, solutions of Terrazole applied at 5 and 15 ppm every two days in a simulated drip system gave very good control of *Phytophthora* root rot, as shown in the following table.

<i>Treatment</i>	<i>Percent of Healthy Roots</i>	<i>Percent of Seedlings with Stem Cankers</i>
None	5	100
Terrazole 5 ppm	80	0
Terrazole 15 ppm	92	0

Appreciation is expressed to the Ciba-Geigy Co., Olin Chemical Co. and the Rhodia Co. for supplying experimental materials for our tests.

In another test, solutions of the sodium salt of the French phosphite fungicide, LS 73-1038, were applied weekly to *Persea indica* seedlings growing in soil infested with the root rot fungus; the higher dosages in particular gave very good control of root rot, as shown in the following table. In contrast with the previous test with Terrazole, these applications were made only once a week, hence the need for higher dosages.

<i>Dosage of LS 73-1038</i>	<i>Avg. Percent Healthy Roots</i>	<i>Avg. Weight of</i>		<i>Avg. Weight of Healthy Roots (grams)</i>	<i>Avg. Increase in Height (cm)</i>
		<i>Roots</i>	<i>Tops</i>		
None	0	0.5	1.3	0.12	0.3
50 ppm	64	1.5	2.56	1.02	0.42
100 ppm	70	1.78	2.38	1.24	0.86
200 ppm	88	1.80	2.86	1.34	1.36

In another test, the Ciba-Geigy fungicide was applied to Topa Topa seedlings and G6 seedlings transplanted into infested soil in the greenhouse. A low dosage (5 ppm) of the fungicide was applied to the soil three times a week. The growth and the percentage of healthy roots was greatly increased in both rootstocks, and good control of root rot was obtained by the applications of CGA 48988, as shown in the following table.

<i>Rootstock</i>	<i>Increase in Height (cm)</i>	<i>Percent Healthy</i>	<i>Weight of Roots (grams)</i>	<i>Weight of Tops (grams)</i>
Topa Topa	7.2	0	31.5	26.5
G6	56.4	42.5	101.3	67.0
Topa Topa treated with CGA 48988	167.1	57.5	646.0	291.0
G6 treated with CGA 48988	164.7	87.5	652.0	435.5

FIELD TRIALS

An important phase of the research program to control avocado root rot is the establishment of field trials to test fungicides that show some promise in controlling the disease in greenhouse tests.

We are currently testing two chemicals, Terrazole and CGA 48988, in ten groves located in San Diego, Riverside, and Santa Barbara counties, in cooperation with Don Gustafson, Don Rosedale, and George Goodall, of the University's Cooperative Extension Service in those counties.

In some of these groves, we are treating trees that are infected with the root rot fungus, as well as healthy trees that are immediately adjacent, in an attempt to check the spread of the fungus. In one of our trials, we are treating infected trees that were cut back severely (stumps) in an attempt to balance the top and the rot system. Additional

tests are planned with the phosphite fungicide, Aliette.

Several of our recent trials are with replant trees in diseased groves. In these tests we are trying low levels of fungicide in combinations with some of our resistant rootstocks.